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<https://orcid.org/0000-0002-5121-432X>, Candice, Christie J. and Pang, Cecilia M. C. (2021)
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Contemporary Practices of Strength and Conditioning Coaches in Professional Cricket

AUTHORS:

Anthony Weldon¹, Michael J. Duncan², Anthony Turner³, Candice J. Christie⁴, Cecilia MC. Pang¹.

AFFILIATIONS:

1. Human Performance Laboratory, The Technological and Higher Education Institute of Hong Kong, Hong Kong.
2. Centre for Sport, Exercise and Life Sciences, Coventry University, Coventry, United Kingdom.
3. London Sport Institute, Middlesex University, London, United Kingdom.
4. Department of Human Kinetics and Ergonomics, Rhodes University, Grahamstown, South Africa.

CORRESPONDENCE:

Name: Anthony Weldon

Address: Room S1226, THEi Building, 133 Shing Tai Rd, Chai Wan. Hong Kong.

Email: anthonydw@hotmail.co.uk

ABSTRACT

This study describes the contemporary practices of strength and conditioning (S&C) coaches in male professional cricket. Thirty-three S&C coaches working with international and professional club teams across seven countries completed an online survey. The survey consisted of 45 questions (35 fixed responses and 10 open-ended), with eight sections: (a)

background information, (b) muscular strength and power development, (c) speed development, (d) plyometrics, (e) flexibility development, (f) physical testing, (g) technology use, and (h) programing. Most S&C coaches were educated to degree level (97%) or higher, with 91% of degrees being in a sports science related field. Whereas, 73% held S&C and 40% cricket coaching certifications. Isometric type resistance training exercises (94%) were frequently programed by S&C coaches, with squats and deadlifts (including variations) deemed the most important strength development exercises. Ratings of perceived exertion (58%) was most used for determining set loads. Hang clean (64%) and multiple hops/lunges (85%) were the most prescribed Olympic weightlifting and plyometric exercises. Speed gates (85%) were the most used technology-based equipment. Open-ended questions revealed, 45% of S&C coaches believed time constraints, scheduling and fixtures are the main issues faced in their role. Position specific demands (61%) was the predominant method used for individualizing players training strategies. The information presented in this study is valuable for those pursuing or currently working as a S&C coach in professional cricket to align, compare and explain their practices. Furthermore, will provide insight for the wider athlete support team (i.e., sports coaches, physiotherapists) on the practices of S&C coaches.

Key Words: exercise selection; physical development; programing; physical testing, technology.

INTRODUCTION

In professional sport, strength and conditioning (S&C) coaches are integral to the athlete's multi-disciplinary support team.^{1,2} The roles and responsibilities of S&C coaches are varied, with the primary objectives of improving physical performance and decreasing injuries.¹⁻⁴ To become a competent S&C coach, academic and professional qualifications can be undertaken,

and current S&C guidelines and scientific literature used to inform practice.^{1,2,5} For example in cricket there is various research available on the physiological and movement demands of different game formats,^{6–11} changes in physical performance across a season,^{12,13} and physical attributes required and possessed for different player roles.^{3,14–22} However, given the lack of research addressing the practices of S&C coaches in professional cricket, it is uncertain whether theoretical and research-informed guidelines are being adopted in actual practice, therefore warranting further investigation.²³

It has been shown that S&C coaches across different countries, sports and expertise levels, recommended using fundamental principles and exercises to provide a strong foundation for S&C programs.²⁴ Whereas, at the professional level this can be more complex, with a need to tailor programs to each players profile (e.g., injury history, goals, and position).^{12,23,25} For example, fast bowlers can bowl at speeds above 140 kph more than 120 times per day during a match.¹ Where higher lower-body power (static jump), upper-body power (bench throw), upper-body strength (one-repetition maximum pull up), and speed (0-20 m sprint time) test scores, have been associated with faster bowling velocities.^{15,20} Batters score runs by hitting a bowled ball over the boundary or repeatedly running between the wickets. Where superior upper-body strength (one-repetition maximum bench press)²² and repeated sprint ability,¹⁴ are related to greater hitting distance and batting running performance. Furthermore, when fielding players repetitively throw a cricket-ball at high velocities. Therefore, S&C coaches are advised to implement progressively overloaded programs including upper-body hypertrophy, maximum strength, strength endurance, and high velocity exercises, to prepare players for high throwing loads, optimize throwing performance and decrease injuries.³ Although there are commonalities in the physical demands and recommended areas for physical development across on-field positions (e.g., upper-body strength), there are differences that S&C coaches should also cater for.

Cricket is unique as players participate in different game formats, and at the professional level, may simultaneously play for their country, franchise and international 20/20 teams. Furthermore, the rising popularity of shorter game formats such as 20/20, has increased the physical demands on players, regarding match intensity and number of fixtures played.¹² For example, approximately 50-100% more maximal sprints are completed per hour during 20/20, compared to multi-day games (i.e., over five days).^{8,9} Therefore, players who can maintain optimal physical condition throughout a season and congested fixture schedules,¹¹ using appropriate physical preparation and recovery strategies, are more likely to consistently perform and reduce injuries.^{26,27} All this information needs to be taken into consideration by S&C coaches when planning and conducting their S&C training programs.

Various studies have investigated the practices of S&C coaches in professional sports, including: American football,²⁸ ice hockey,²⁹ baseball,³⁰ basketball,³¹ rugby union,³² swimming³³, and cricket²³. However, the cricket study had a very small sample size ($n = 5$) of S&C coaches working in a professional South African franchise league.²³ Although this study provides valuable insight, it is not possible to make strong inferences regarding the practices of these S&C coaches or whether practices can apply generally across S&C coaches in different leagues and countries. To gain a more detailed understanding of the contemporary practices of S&C coaches, a more global sample is required.

Therefore, the purpose of this study was to investigate the practices of S&C coaches from various countries where professional cricket is played. This analysis will help identify the consistency between proposed guidelines and actual practice, while also facilitating the development of cricket-specific research and education resources in S&C.

METHODS

Experimental Approach to the Problem

This cross-sectional explorative study was designed to provide descriptive information about the practices of S&C coaches in professional international and club cricket, from different countries and leagues. Participating S&C coaches were required to describe their practices, to provide an understanding of their application and knowledge of S&C principles in cricket. Opinions were also sought on issues, programing and future trends related to S&C in cricket. The survey was developed using open access survey administration application Google Forms and slightly modified from previous research²⁴ to specifically survey S&C coaches in professional cricket (e.g., Q9. what professional cricket qualifications do you hold)? The survey comprised of eight sections: (a) background information, (b) muscular strength and power development, (c) speed development, (d) plyometrics, (e) flexibility, (f) physical testing (g), technology used, and (h) programing. The survey included 35 fixed response and 10 open-ended questions, and coaches could provide specific answers using the “other” option for most questions (see Appendix 1). Some questions allowed more than one response to be selected, meaning some questions had more responses than others. Pilot testing was conducted by all members of the research team, then by three accredited S&C coaches, for a total of three rounds before the survey was finalized. Pilot testing led to slight modifications to the wording and structure of the survey to avoid ambiguity in terms that may have varying definitions, and to ensure validity for use with this population. The study was approved by the Research Ethics Committee of ***Removed for peer review***.

Subjects

Purposive sampling was used to recruit S&C coaches in male professional cricket through available online biographies, therefore participation was by invitation only. S&C coaches were sought from the top 10 ranked countries in 20/20, one-day, and multi-day cricket formats at the

time of data collection.³⁴ The search included international teams and professional clubs in: Afghanistan, Australia, Bangladesh, England, India, Ireland, New Zealand, Pakistan, South Africa, Sri Lanka, West Indies (i.e., Trinidad and Tobago), and Zimbabwe.

All coaches provided informed consent to initiate the anonymous online survey, and only fully completed surveys were used for analyses. The survey started with an explanation of the purpose, aims, required time-commitment, and confidentiality of information. Coaches were informed a copy of results may be sent upon request.

Statistical Analyses

All responses from Google Forms were downloaded into an Excel 2016 spreadsheet (Microsoft Corporation, Redmond, WA). Fixed response questions were assessed using a frequency analysis. Open-ended response questions were assessed using a thematic analysis approach³⁵, with the following six-stage process: (a) familiarization with the data, (b) generating initial codes, (c) searching for themes, (d) reviewing themes, (e) defining and naming themes, and (f) producing the report. This method of thematic analysis has been used previously in studies surveying S&C coaches.^{24,33} Thereafter, overarching clear and identifiably distinct themes, representing the main ideas or patterns emerging from the raw data were generated for each open-ended question.

RESULTS

Background Information

Thirty-three S&C coaches with a mean age of 34.7 ± 7.6 years and S&C experience of 10.6 ± 5.9 years, participated in this study. The response rate was similar to prior surveys in other professional sports ($n = 20-43$),²⁸⁻³³ and higher than a survey conducted in professional cricket

(n = 5).²³ Responses were received from seven countries where S&C coaches worked with professional international and club teams (see Figure 1).

Professional cricket coaching certifications were held by 40% of S&C coaches, with the most reported being a Cricket South Africa (CSA) Level 2 (12%), English Cricket Board (ECB) Level 2 (9%), and CSA Level 3 (6%). Degrees were held by 97% of S&C coaches and 91% were in a sports science related field. The most reported degree levels were: Master's degree (63%), Bachelor's degree (34%), and Doctorate of Philosophy (PhD) (3%). Strength and conditioning certifications were held by 73% of coaches and 12% held more than one. The most reported S&C related certifications were: United Kingdom Strength and Conditioning Association (UKSCA) Accredited Strength and Conditioning Coach (ASCC) (36%), National Strength and Conditioning Association (NSCA) Certified Strength and Conditioning Specialist (CSCS) (24%), and Australian Strength and Conditioning Association (ASCA) Strength and Conditioning Coach Accreditation (15%). A S&C internship was completed by 76% of coaches and were completed: before certification (67%), during certification (36%) and after certification (24%).

Insert Figure 1 about here

Muscular Strength and Power Development

Off-Season: Variability in the reported number of strength training sessions conducted each week were: 3 sessions (64%), 4 sessions (30%), 2 sessions (27%), 5 sessions (9%), and 6 sessions (9%). Whereas, 46-60 min (57%), 61-75 min (36%), 31-45 min (30%), 76-90 min (18%), and 15-30 min (3%), were the most reported length of time for strength sessions. The most prescribed set ranges were: 3-4 (88%), 5-6 (61%), 1-2 (24%), and 7-8 (9%). Other responses included: "Set ranges are 2-5, but mostly 3-5 range off-season, we hardly ever do

more than 5 sets” and “Depends on the phase we are working on”. The most reported repetition ranges used per set were 4-6 (82%), 1-3 (49%), 10-12 (46%), 7-9 (42%), 13-15 (12%), and 15+ (9%). Other responses included: “Main exercises 3-5 reps and assistance exercises typically 8-12 reps, depending on the exercise and objective” and “7+ for assistance exercises”.

In-Season: Variability in the reported number of strength training sessions conducted each week were: 2 sessions (67%), 1 session (52%), 3 sessions (42%), and 4 sessions (12%). Whereas, 31-45 min (70%), 16-30 min (46%), 46-60 min (42%), 61-75 min (12%), 76-90 min (3%), and 0-15 min (3%), were the most reported length of time for strength sessions. Other responses included: “30-45 min session’s in-season, but try to keep shorter”. The most prescribed set ranges were: 3-4 (91%), 1-2 (61%), and 5-6 (15%). Other responses included: “2-5 set and rep range in-season, however, more work in 2-3 set range to reduce volume”. The most reported repetition ranges used per set were: 4-6 (94%), 1-3 (39%), 7-9 (27%), and 10-12 (15%). Other responses included: “Main exercises usually 3-5 reps and assistance exercises typically 8-12 reps”, “I use the same rep ranges in and out of season”, and “as per individual needs”.

Periodization, Set Loads and Recovery: Periodization strategies were used by 97% of coaches to structure programs and other responses included “Given the seasonal nature of our league we do not have full control of players’ workload and schedules. Players arrive 7 days before league commencement and leave thereafter, returning to domestic or international programs”. The most used methods for determining set loads are presented in Figure 2, and other responses included: “Sometimes based on how the athlete feels may change the planned loads”, “Players use session RPE [rating of perceived exertion], indicating the desired session intensity”, “reps in reserve”, and “technical breakdown”. Recovery time prescribed by S&C coaches between S&C training, sports practice and competition is presented in Table 1.

Insert Figure 2 and Table 1 about here

Resistance Training: All S&C coaches used resistance type training, with concentric (94%), isometric (94%), eccentric (91%), variable (e.g., bands and chains) (76%), machine (33%), and isoinertial (e.g., flywheel) (15%), being the most common modes of resistance exercises prescribed. Other responses included: “Kettlebells, barbells, dumbbells, resistance bands and bodyweight are the main forms of resistance used, machines are used sparingly and typically only for specific rehab exercises” and “Whatever’s needed to get the desired stimulus response”. Olympic weightlifting and associated derivatives were used by 88% of coaches. An overview of the most prescribed Olympic weightlifting exercises are presented in Figure 3. Other responses included: “Trap bar pulls and jumps”, “Split snatch/clean, dumbbell single arm snatch, and dumbbell jerk”, and “Use for some competent athletes but not a go to”. The top five weightlifting exercises prescribed by S&C coaches within their training programs were ranked in order, responses are presented in Table 2.

*** Figure 3 and Table 2 about here***

Speed Development

Speed development exercises were used by all S&C coaches, an overview of the most common exercises prescribed are presented in Figure 4.

Insert Figure 4 about here

Plyometrics

All S&C coaches used plyometric exercises, an overview of the purposes for prescribing these exercises is presented in Figure 5. Other responses included: “Stiffness”, “Used sparingly in our league, and for most players not at all”, “Maximal expressions of the athlete’s strength and power”, and “transfer to cricket skill performance”. The time of year that plyometric exercises were prescribed by S&C coaches, was predominantly all year round (73%), pre-season only (24%), in-season only (15%), off-season only (9%) and at training camps (6%). Whereas, plyometric exercises were mostly programed into S&C sessions, before weights (55%), as complex training (52%), on separate days (42%), and after weights (9%). The plyometric exercises prescribed by S&C coaches are presented in Figure 6, and other responses included: “Plyometrics are used, but are not a big part of my program”, “Banded trunk rotational plyometrics”, and “Pogos, sprinting itself, hurdle work, and rhythm hopping”.

Insert Figure 5 and 6 about here

Flexibility Development

Flexibility exercises were used by all coaches, with the most common times for prescription presented in Figure 7. Other responses included: “We have prehab sessions for injury prevention based exercises”, “Mobility drills first and last thing”, “Through Pilates sessions”, “Before training is dynamic and mobility work” and “We have standalone mobility sessions largely based around yoga”. The most reported length of flexibility sessions were: 6-10 min (70%), 11-15 min (55%), 0-5 min (30%), 16-20 min (27%), and 21+ min (15%). Other responses included: “Pilates are up to 60 mins”. The frequency that S&C coaches prescribed different methods of flexibility exercise is presented in Table 3.

Insert figure 7 and Table 3 about here

Physical Testing

Physical testing was used by all coaches, and predominantly conducted: all year round (67%), pre-season (33%), off-season (27%), in-season (24%), and at training camps (15%). Other responses included: “Full battery of testing off-season and pre-season, and individuals monitored in-season for tests specific for their development or injury prevention”, “Many squad members arrive a few days before the league commences, limiting the type and quantity of testing performed, we seldom see players in the off and pre-season”, and “We use different tests at different times of the year/season”. An overview of the most reported physical tests are presented in Figure 8. Other responses included: “Velocity based training”, “Reactive strength index”, “Bowling velocity”, “Movement quality assessment”, “Limited opportunities to test in our league, particularly physically demanding tests”, “Main assessments include body composition, musculoskeletal screening and baseline speed”, “Other tests (strength and cardiovascular endurance) are done with non-selected players”, and “In-season we do a few regular assessments, whereas off-season and pre-season we do a greater range of tests”.

Technology Use

Technology-based equipment was used by all coaches, with speed gates (85%), global positioning system (GPS) (49%), electronic jump mats (49%), mobile phone applications (49%), heart rate monitors (49%), wearable technology (e.g., smart watch) (42%), body composition analyzers (36%), bar velocity trackers (30%), video analysis software (30%), and force plates (30%) being the most used. Other responses included: “Morning heart rate variability”, “Isokinetic dynamometer for specific individuals”, and “Gym equipment for strength testing”.

Athlete wellbeing was monitored by 91% of coaches, with mobile device questionnaires (64%), verbal questionnaires (24%), and written questionnaires (24%), being the most used methods. Other responses included: “Just through conversation and building a rapport”, “Instant messaging, phone call or conversation”, “Chat to players on a regular basis”, and “Regular communication, and observing players”.

Insert Figure 8 about here

Programing

Five open-ended questions were asked, allowing detailed responses from S&C coaches, which were used to create higher order themes. The percentage of responses to each theme and exemplar responses are provided in Tables 4-8.

Insert Tables 4, 5, 6, 7 and 8 about here

DISCUSSION

This is the first study to investigate the practices of S&C coaches in male professional cricket across different countries and leagues. A bachelor’s degree or higher was held by most S&C coaches in this study, and more than reported (80%) in another professional cricket survey.²³ Furthermore, over half held a Master’s degree and very few held a PhD, similar to previous surveys of S&C coaches in rugby union³² and across various sports and countries.²⁴ Almost three quarters of S&C coaches held a S&C certification, which is higher than reported in professional swimming³³ (58%), professional rugby union³² (56%) and Division II American Football³⁶ (38%). It is recommended that S&C coaches complete academic qualifications (i.e., Bachelor degrees and preferably Master degrees), along with professional qualifications (i.e.,

S&C accreditations) to provide underpinning theoretical knowledge and practical experience in sports science and S&C.⁵ Therefore, it is promising to see the highly qualified S&C coaches currently working in professional cricket.

Undertaking internships or graduate assistantships to develop S&C knowledge and skills are important.³⁷ However to be considered for positions, candidates are increasingly required to possess professional certifications.⁵ In this study most internships were completed before obtaining professional certifications, which is logical to develop self-efficacy, S&C skills and knowledge before funding a certification.³⁸ This was the first study to address if S&C coaches also possessed cricket coaching certifications, which almost half did. Responses from open-ended questions (see Table 8) suggest that obtaining cricket coaching certifications and developing cricket-specific knowledge will become increasingly important for S&C coaches in the future. For example S&C coaches implied they may be required to contribute more broadly to field based and technical work, and that S&C and sports coaching roles may merge, leading towards a transdisciplinary athlete support team.

Training load was reduced in-season through decreasing the frequency and length of training sessions, and number of sets per exercise in this study. This is similar to S&C coaches in professional rugby union, who adopted a maintenance approach to ensure players were in optimal condition for competition.³² Furthermore, S&C coaches predominantly used 3-4 sets of 4-6 reps for strength development in-season and off-season, aligning with research guidelines for strength training load parameters in cricketers.^{3,12,13} To determine set loads used within training programs, S&C coaches predominantly used RPE, while other methods such as percentage of repetition maximum methods were used to less extent. The use of RPE and predicted repetition maximum methods are beneficial for developing muscle growth and maximal strength, but there may be small additional gains in muscular strength using a RPE method,³⁹ aligning with the results from this study.

Periodization strategies were used by almost all S&C coaches in this study, and to a greater extent than S&C coaches in other professional sports, including: ice hockey²⁹ (91%), rugby union³² (88%), baseball³⁰ (86%), basketball³¹ (85%), and American football²⁸ (69%). Periodization strategies are beneficial in organizing short and long term S&C programs, however, constraints in professional sport require S&C coaches to continuously adapt and modify periodized plans.² This is apparent from some of the reported ‘biggest issues’ faced by S&C coaches being: time, scheduling, fixtures and training load (see Table 4). Predominantly, S&C coaches prescribed <24 h (same day) (61-79%) between strength, power and speed development sessions and sports training (see Table 1), similar to S&C coaches in professional rugby union (72-79%). In contrast, 48 h (39-42%) was considered suitable between such sessions and competition, slightly lower than reported in rugby union (47-51%). Although comparisons with prior research and other sports is insightful the congested playing schedules in some cricket formats, creates substantial restrictions for S&C coaches. Such as the difficulty in planning and applying ideal periodized training programs and recovery strategies, which is apparent from open-ended responses in Table 4.

The use of isometric exercises in male professional cricket was considerably higher than reported by S&C coaches working across various sports²⁴ (73%), potentially suggesting additional sport-specific benefits in cricket. Some S&C coaches suggested isometric exercises can be used throughout the season, will be further integrated in the future, and can help deal with the high isometric demands of fast bowling (see Tables 5, 6, and 8). It has been recommended cricketers perform isometric exercises to resist ineffective trunk extension, flexion and lateral flexion under loads, particularly when moving at high velocities (e.g., when performing cricket specific skills).³ Eccentric exercises were also widely used in this study, deviating from a survey on the S&C conditioning practices of sports coaches in sub-elite cricket, which revealed only 18% of practitioners used eccentric exercises.⁴ The authors of this

study suggested this was due to coaches' lack of experience and qualifications in S&C, while potentially not fully understanding the importance and application of eccentric exercise for performance and injury reduction benefits.⁴

Olympic weightlifting and associated derivatives were prescribed by most S&C coaches in this study, similar to other professional sports: basketball³¹ (95%), ice hockey²⁹ (91%), rugby union³² (88%) and American football²⁸ (88%). The most used Olympic weightlifting exercises prescribed were derivatives (see Figure 3), which have been recommended to improve acceleration, speed, and ankle/knee stiffness,⁴⁰ which are key physical attributes for bowlers.¹⁵ Conversely, just over one third of S&C coaches used Olympic weightlifting for speed development (see Figure 4), showing a disparity between the potential benefits and actual usage of Olympic weightlifting in professional cricket.

The squat, deadlift and associated derivatives were deemed the most important exercises prescribed by S&C coaches for professional cricketers (see Table 2). This is similar to that reported by S&C coaches in other professional sports: American Football,²⁸ ice hockey,²⁹ baseball,³⁰ basketball,³¹ rugby union,³² and swimming.³³ Using these exercises in a comprehensive S&C program with elite cricketers has demonstrated improvements in various power, speed, strength, agility, and cardiovascular endurance physical tests.^{12,13} However, improvements were only seen during the off-season where two sessions were completed per week, but when only one maintenance session per week was conducted in-season, a gradual decline in physical test performance was observed.¹³ The use of two maintenance sessions in-season was most commonly reported in this study, suggesting S&C coaches in professional cricket are aware of the importance of maintaining a suitable training stimulus to prevent a decline in physical performance.

The most prescribed speed development exercises were plyometrics and maximum speed sprinting. In cricket mean sprint distances for fast bowlers during the run up is

approximately 15.2 - 17.7 m,⁴⁰ batters sprint 17.68 m between the wickets,⁴¹ and cricket fielders sprint 15 - 18 m on average in the field.¹⁰ The use of plyometrics may be more applicable to develop short accelerative sprints (i.e., <20 m) that mimic sport-specific distances, as opposed to achieving maximal sprinting velocities that require greater distances.¹⁹ However, less than half of S&C coaches used sport-specific movements to develop speed. Open-ended responses suggested this is achieved through combining technical and physical skills to apply a sport-specific training stimulus (i.e., distance of sprints) (see Table 5).

Plyometric exercises were mostly prescribed before weights, which is logical given the important requirements of movement quality and explosiveness, which is best achieved when less fatigued (e.g., before heavy weight training).² The predominant reasons for using plyometrics were for speed development, lower-body power and injury reduction, and the most prescribed plyometric exercise was multiple hops/lunges. It was surprising the limited prescription of plyometrics for upper-body power and use of upper-body plyometric exercises (see Tables 5 and 6). Particularly given the important injury reduction and performance implications of being able to conduct repetitive upper-body explosive cricket movements (i.e., bowling, batting and throwing).^{3,19,22,40} For example, conducting eight-weeks of explosive upper-body exercises with resistance bands and medicine balls, significantly improved bowling velocity by an average of 2.64 km/h.⁴² Plyometric exercises were predominantly prescribed all year round, but extensively focusing on plyometrics for long periods of time may be inappropriate due to their high intensity.² However, plyometric exercises can offset performance decrements and improve lower-body power in professional cricketers, when suitably periodized with adequate recovery in a comprehensive S&C program over a six-month period.¹²

Flexibility exercises were mostly prescribed before practice in this study, and used to a lesser extent during this period than S&C coaches in other professional sports: baseball³⁰

(95%), American football²⁸ (92%), basketball³¹ (90%), rugby union³² (79%), and ice hockey²⁹ (78%). Dynamic flexibility exercises were most used, and flexibility sessions were predominantly kept relatively short (i.e., 6-10 mins) in this study. Given the lack of evidence in professional cricket regarding the performance benefits of different warm ups, it is assumed S&C coaches were adhering to general warm up principles of a short dynamic stretching routine prior to training. Although, it has been shown in sub-elite Indian university standard cricketers that conducting a 10 min routine of jogging (5 min) followed by five sets of dynamic (30 sec) and static (30 sec) stretches of the lower-body, significantly improved performance in subsequent flexibility (sit and reach), agility (Illinois agility test) and speed (0-20 m sprint) tests, compared with routine stretching.⁴³ However, it was unclear from the methodology what specific stretches were conducted in any of the groups.⁴³

Cardiovascular endurance and body composition were the most common physical tests used in this study. Professional cricketers require high levels of cardiovascular endurance, to cover a large proportion of distances at low intensities during different cricket game formats.^{8–11} Furthermore, strong cardiovascular endurance supports the ability to perform repeated bouts of high-intensity aerobic work, which is considered important for professional cricketers.¹² For example the English Cricket Board have stipulated players should be able to achieve a minimum standard of level 18.7 in the Yo-Yo Intermittent Recovery Test Level One.¹² Regarding body composition, there is limited evidence to suggest that body composition has a positive impact on performance across cricket positions. Although not specifically surveyed in this study, body composition data may provide S&C coaches with useful information to establish whether S&C programs are providing the desired adaptations (e.g., decrease in body fat percentage following a block of conditioning training). A study assessing anthropometric, physical strength, body composition and performance test profiles of Indian inter-district level male cricketers (n = 271), found lower body fat percentages were significantly correlated with

batting specific speed and agility tests, but bodyweight, basal metabolic index, and lean body mass were not.⁴⁴ However, these results may not be comparable to professional male cricketers given this study was conducted with sub-elite cricketers, with no indication of players receiving any prior S&C training.⁴⁴

Technology-based equipment was widely used by S&C coaches, and open-ended questions revealed S&C coaches believed technology will continue to evolve and be important for S&C practices in the future (see Table 8). Speed gates were the most popular equipment, coinciding with the common prescription of maximum speed running for speed development. Therefore, it is assumed regular speed assessments are used to determine whether S&C programs have been effective in improving acceleration and speed, which are key physical attributes for cricket performance.^{8–11,15,41} Athlete wellbeing was monitored by most S&C coaches in this study, who predominantly used mobile device questionnaires to obtain this information. Using subjective measures to monitor athlete wellbeing are valid, reliable and sensitive to acute and chronic training loads.⁴⁵ Furthermore, the information provided can cover a range of areas including: stress, fatigue, recovery, and health, which assists S&C coaches in making informed decisions on their interactions with players, and modifications to S&C programs.⁴⁵

PRACTICAL APPLICATION

The data presented in this study provides a useful resource for S&C coaches working in professional cricket. Results suggest that S&C coaches should implement fundamental S&C principles (i.e., periodization, physical testing) and exercises (i.e., squat, deadlift). However, S&C coaches should be conscious of staying up-to-date with current developments in S&C. For example, the continued integration and development of technology to monitor, test and evaluate player's physical and sports performance. This is important given the growing

responsibility and ability for S&C coaches to interpret, disseminate, and apply acquired data. Therefore, S&C coaches are encouraged to undertake academic, professional and sport-specific qualifications, to help develop key knowledge and skills, while remaining abreast of research informed developments in S&C and cricket.

CONCLUSION

This study provides original evidence on the contemporary S&C practices of S&C coaches working in male professional cricket. Similarities were observed with S&C coaches in other professional sports, such as: reducing S&C training loads in-season, common use of Olympic weightlifting, and squat and deadlift being the most important strength training exercises. Whereas, differences observed specific to cricket compared to other professional sports were: extensive prescription of isometric exercises, greater utilization of periodization strategies, and less use of flexibility exercises prior to practice. The information presented is valuable for those pursuing or currently working as a S&C coach in professional cricket to align, compare and explain their practices. Furthermore, will provide insight for the wider athlete support team (i.e., sports coaches, physiotherapists) on the practices of S&C coaches. The knowledge gained from this study can inform future research in developing guidelines on effective S&C practices in cricket.

LIMITATIONS

Although this study received responses from S&C coaches across seven countries, 63% were currently working in England and South Africa, therefore results may be more attributable to these countries. Furthermore, this study provides the opinions and practices of S&C coaches from select countries and leagues, which may not be representative of all S&C coaches working in professional cricket. Lastly, the required number of questionnaires for valid analysis was not

determined prior to data collection, it was aimed to obtain as many responses as possible within this purposive sample of S&C coaches.

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Figures

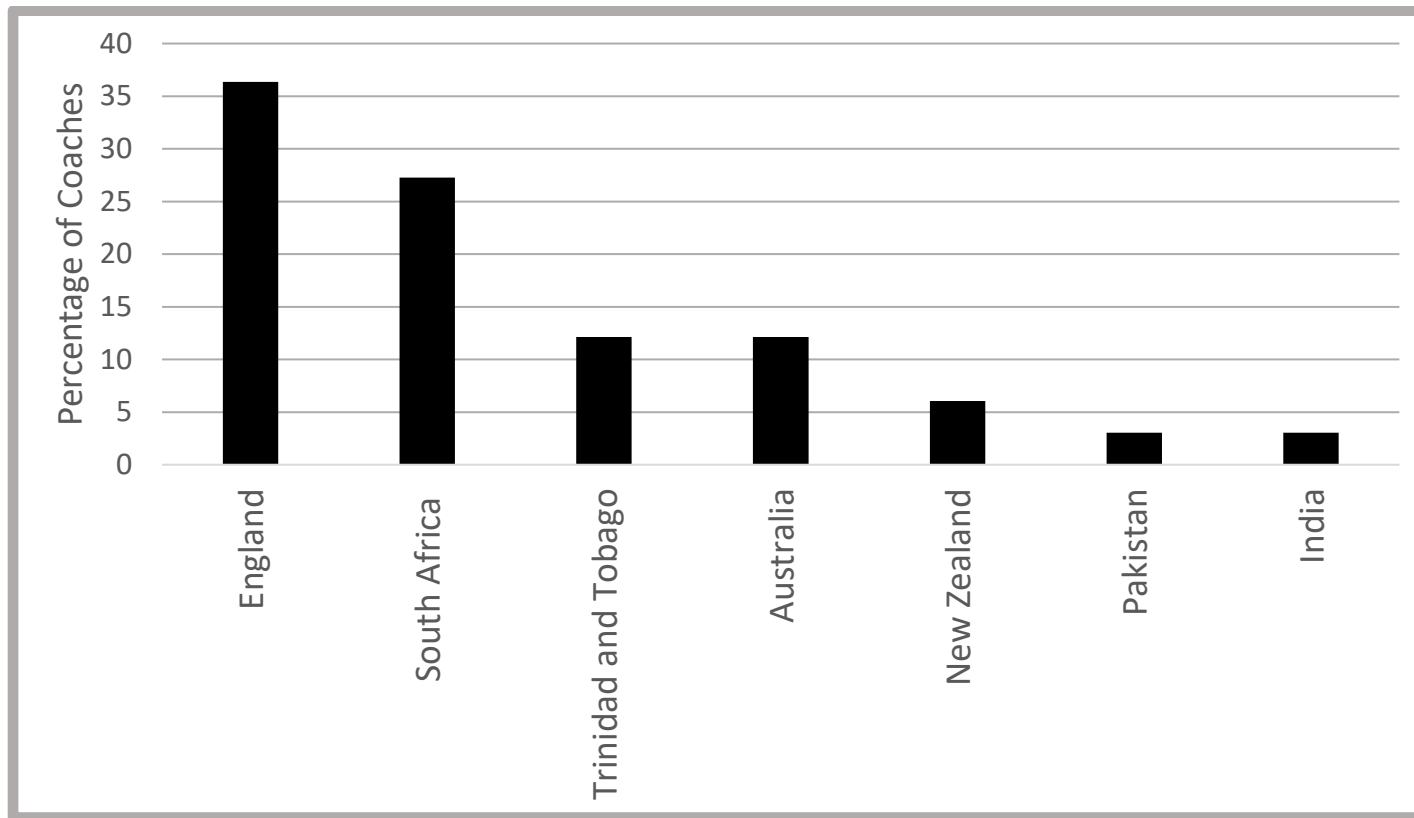


Figure 1. Countries of the professional leagues and/or teams strength and conditioning coaches (n = 33) work.

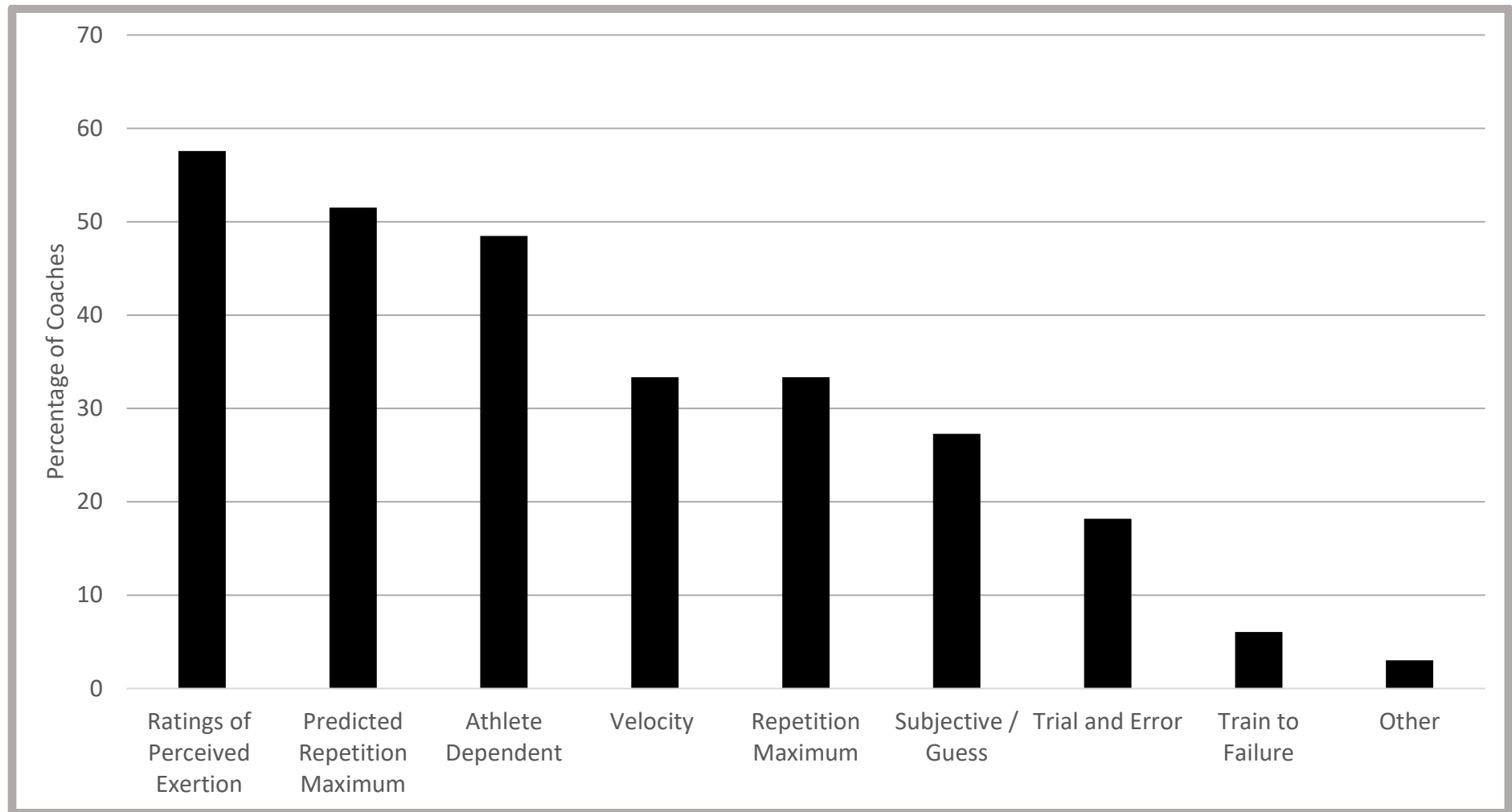


Figure 2. Methods used by strength and conditioning coaches (n = 33) to determine set loads.

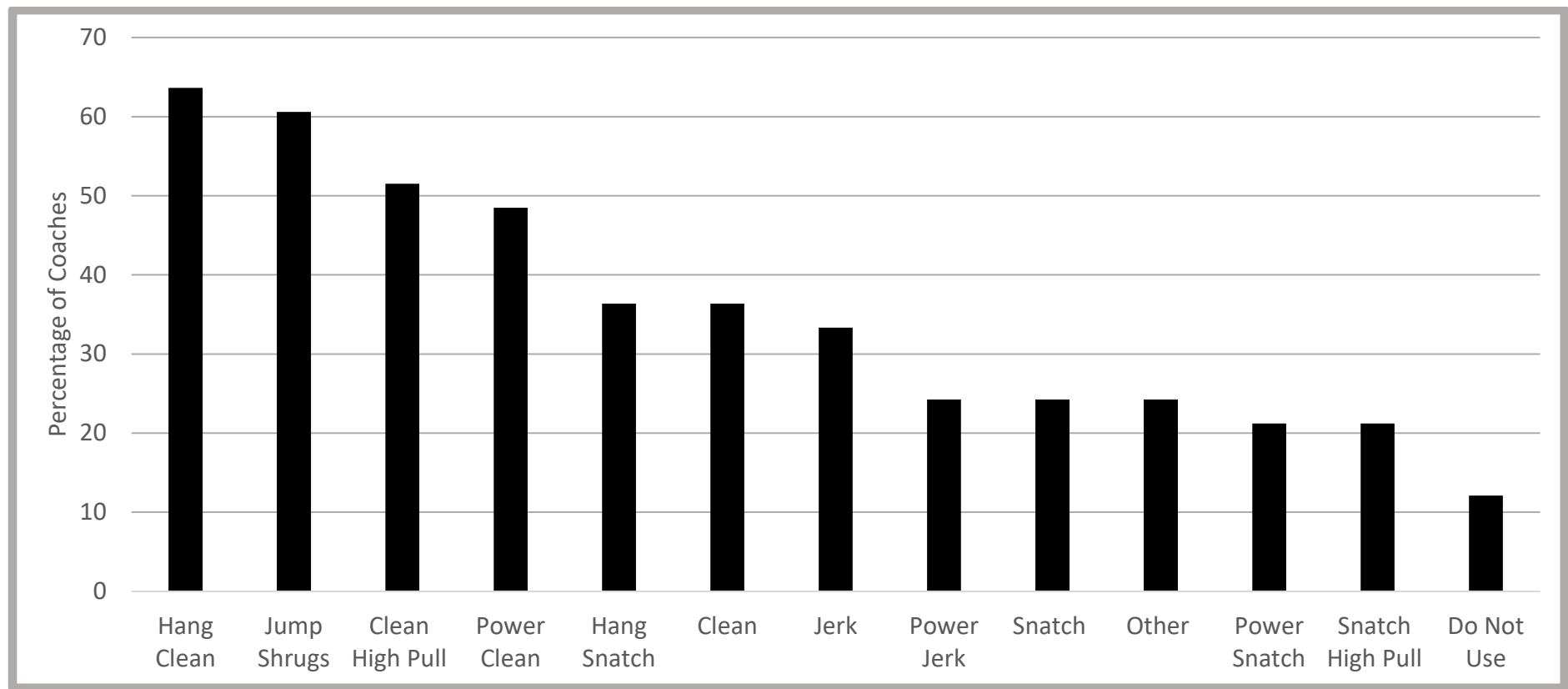


Figure 3. Olympic Weightlifting exercises strength and conditioning coaches (n = 33) prescribe.

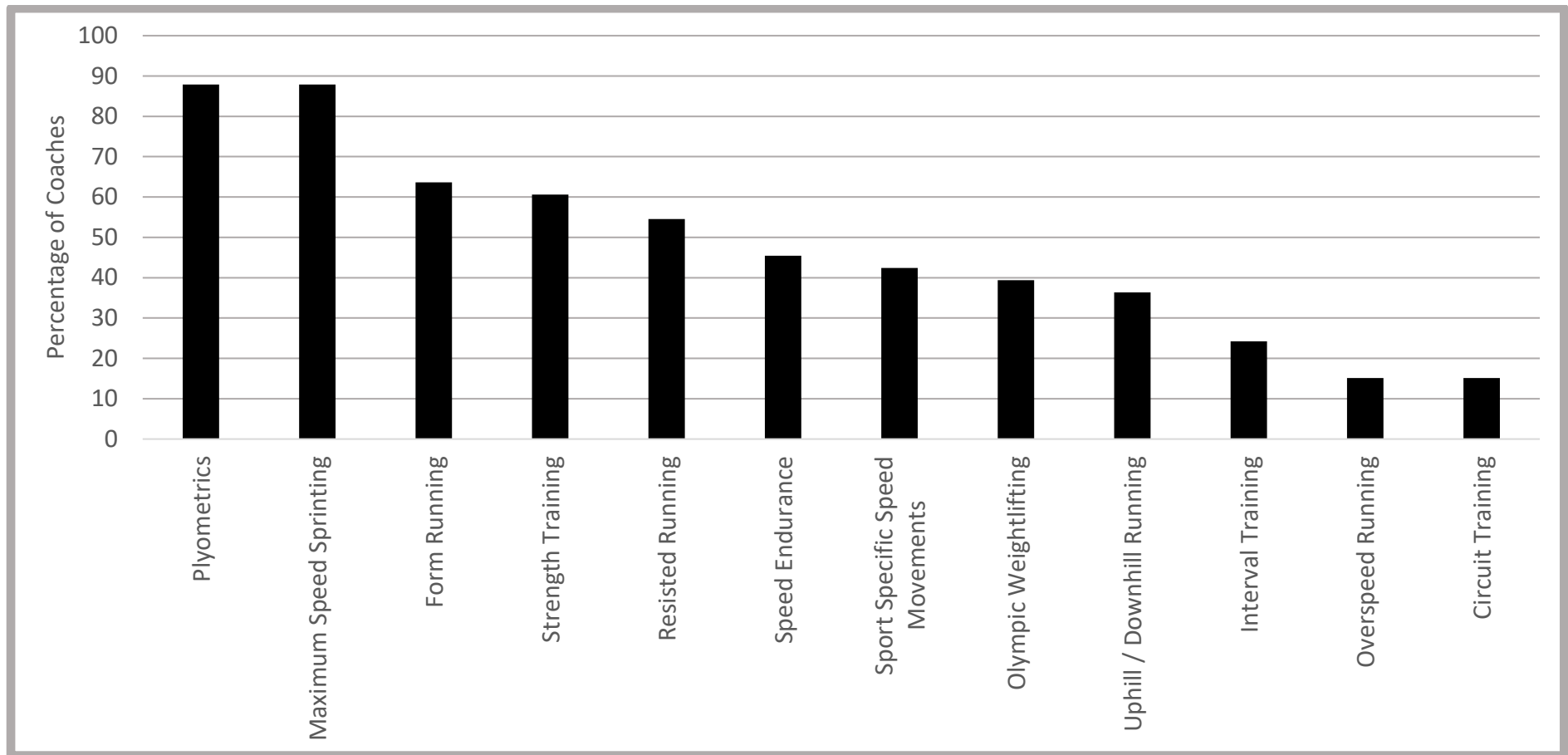


Figure 4. Speed development exercises strength and conditioning coaches (n = 33) prescribe.

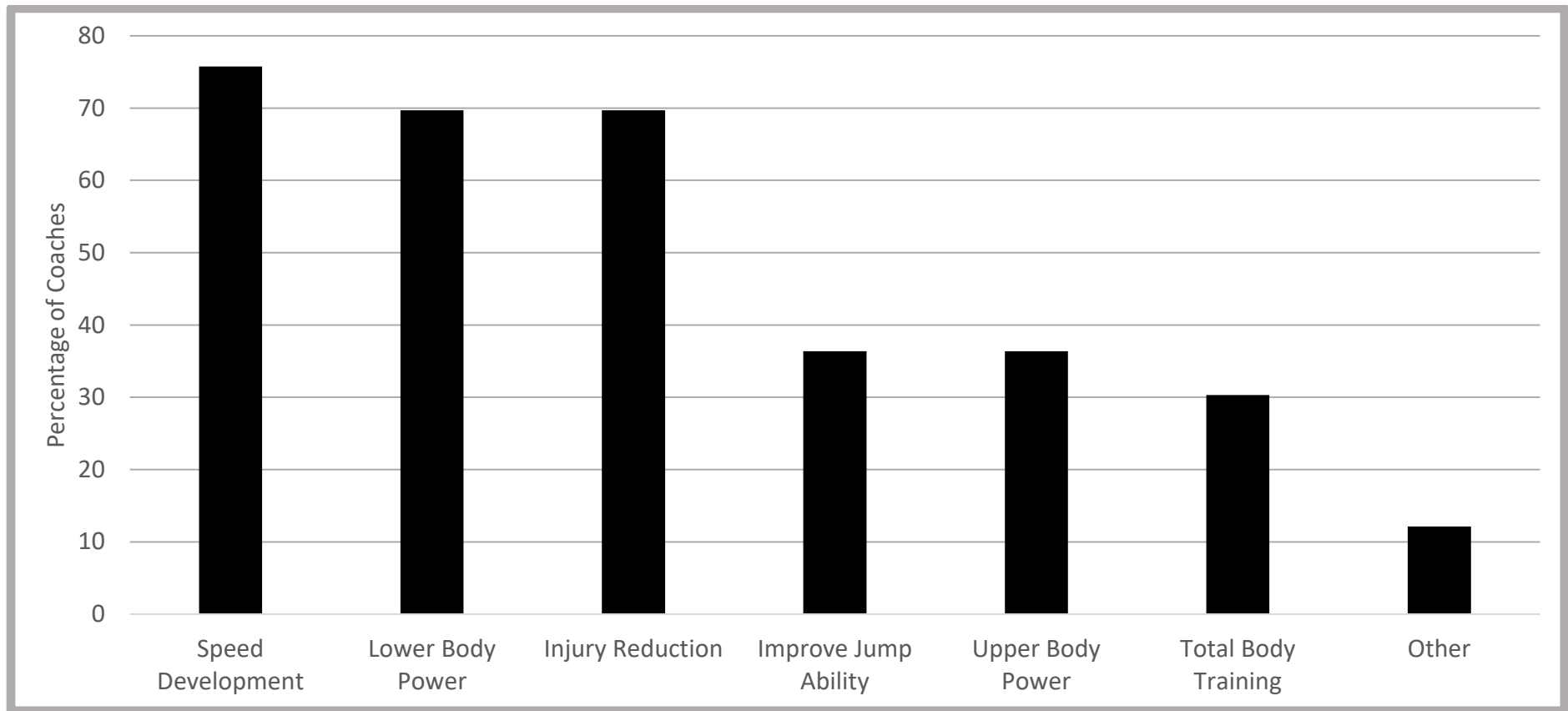


Figure 5. Different purposes for prescribing plyometric exercises and the percentage of strength and conditioning coaches ($n = 33$) who reported each purpose as their basis for using plyometrics.

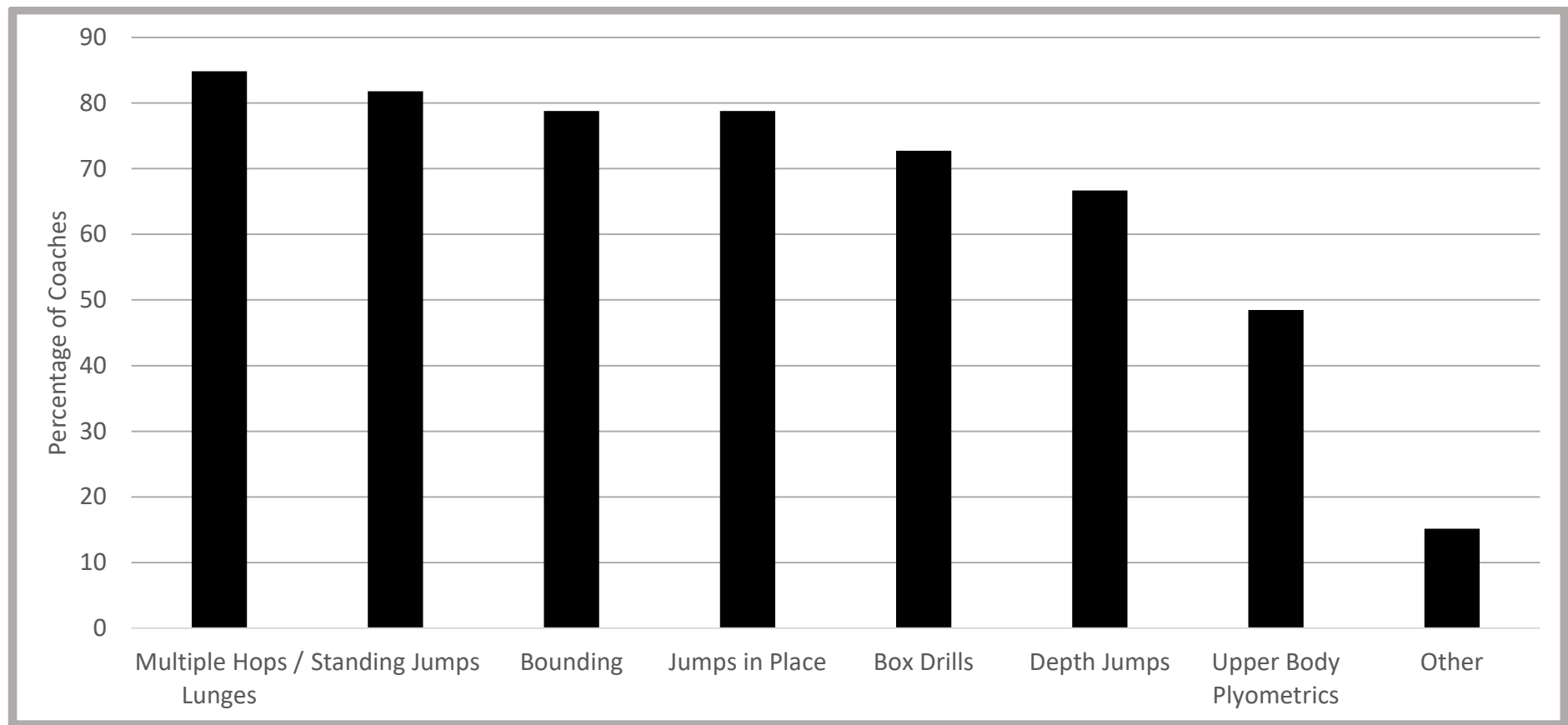


Figure 6. Plyometric exercises strength and conditioning coaches (n = 33) prescribe.

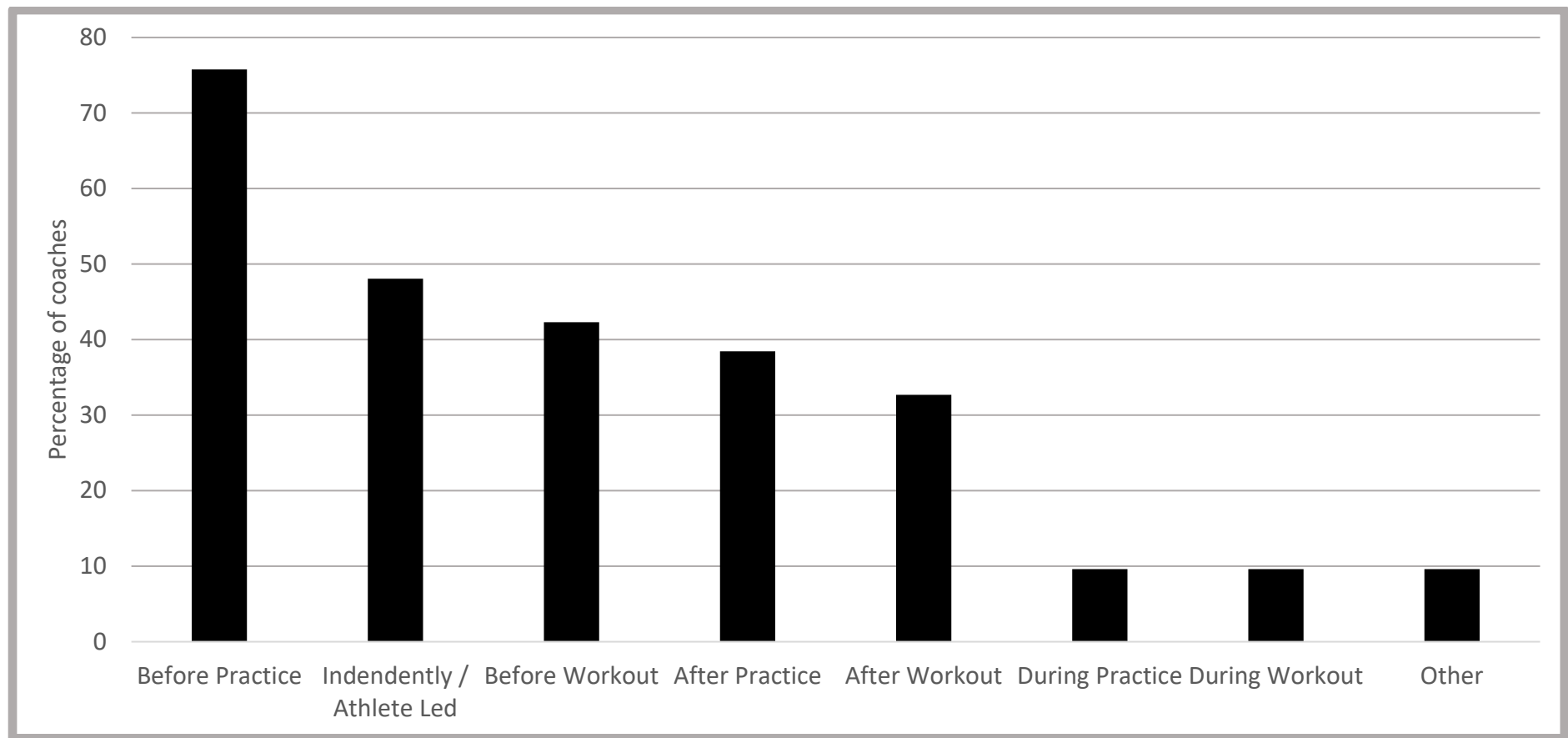


Figure 7. Different times for prescribing flexibility exercises and the percentage of strength and conditioning coaches (n = 33) who reported prescribing flexibility exercises at these times.

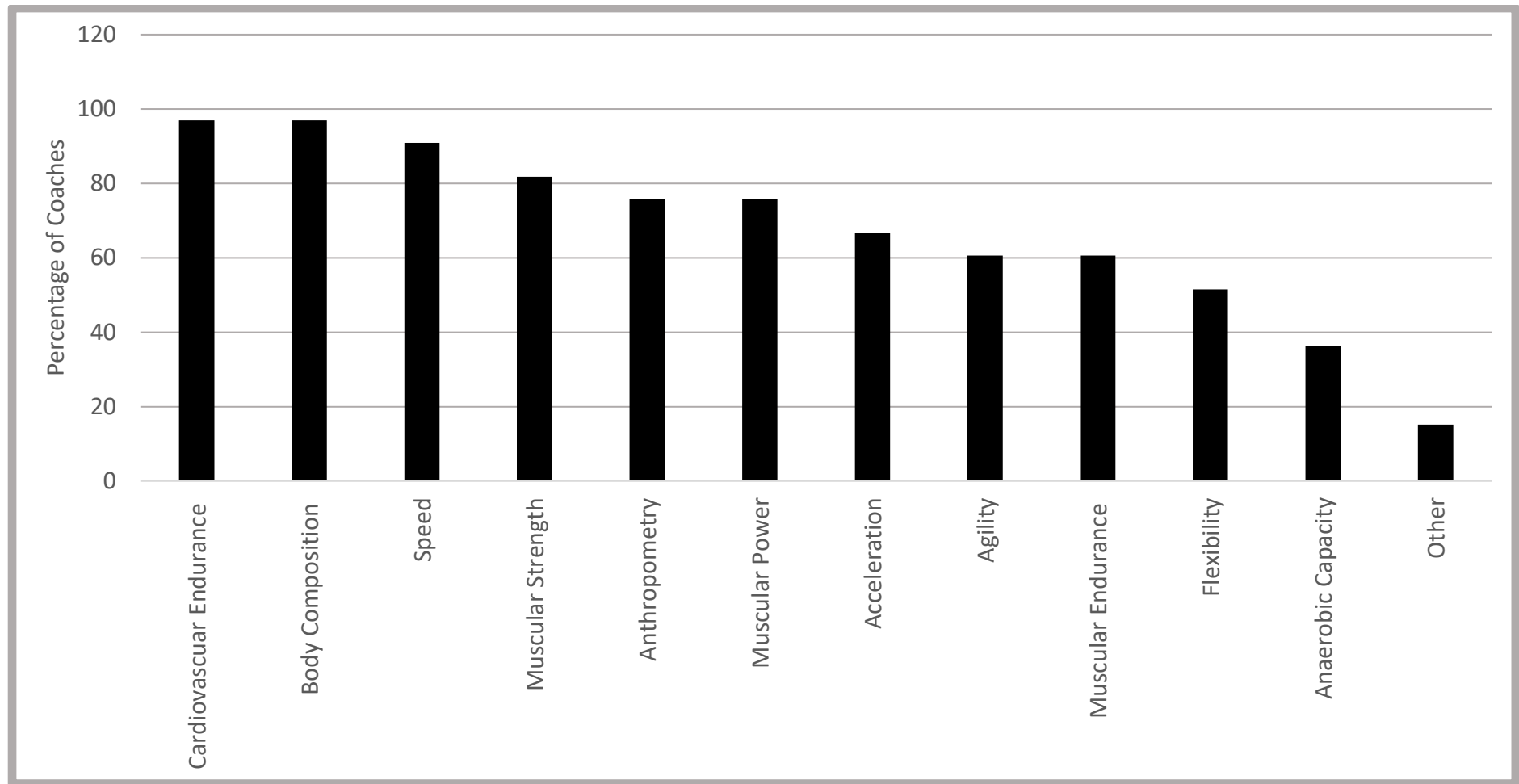


Figure 8. Different physical tests used by strength and conditioning coaches and the percentage of strength and conditioning coaches (n = 33) who reported using each physical test.

Tables

Question	On the Same day	24 h	36 h	48 h	>48 h
Recovery time between speed development and sports training session	79%	18%	0%	3%	0%
Recovery time between strength / power development and sports training session	61%	30%	3%	6%	0%
Recovery time between speed development and competition	6%	27%	21%	42%	3%
Recovery time between strength / power development and competition	9%	27%	18%	39%	6%

Table 1. The duration of recovery time that strength and conditioning coaches (n = 33) prescribed between speed, strength and power development sessions with sports training and competition.

Order of Importance	Exercises	Percentage of Coaches (n = 33)
1	Squat and Variations	55%
	Deadlift and Variations	33%
	Clean and Derivatives	6%
	Glute Activation, Core Exercises	3%
	Other: Bilateral/Unilateral Hip Dominant Exercise, Single Leg Hip Dominant, Total Body Circuit Training, Bilateral Lower Body, Individual Development Exercises, Lifts/Pulls	n/a
2	Deadlift and Variations	36%
	Squat and Variations	18%
	Clean and Derivatives	9%
	Hip Thrust and Variations, Snatch and Derivatives	6%
	Jerk and Variations, Glute Ham Raise, Lunge and Variations	3%
	Other: Single Leg Knee Dominant, Bilateral/Unilateral Knee Dominant Exercise, Lower Body Pull, Push/Pull Training, Eccentric Hamstring, Unilateral Lower Body	n/a
3	Clean and Derivatives	24%
	Deadlift and Variations	15%
	Push Press, Lunges and Variations	9%
	Push Up, Snatch and Derivatives, Jerks and Variations, Squat and Variations	6%
	Pull Up, Mid-Thigh Pull, Hip Thrusts and Variations, Farmers Walk, Core Exercise, Calf Raise	3%
	Other: Bilateral/Unilateral Hamstring, Upper Body Pull, Power Lifting, Reverse Pull, Multi-Planar Lower Body, Fast Bowlers - Isometric Single Leg Triple Extension	n/a
4	Pull Up	15%
	Squat and Variations	15%
	Clean and Derivatives	9%
	Bench Press, Deadlift and Variations, Lunge and Variations, Plyometrics, Jerk and Variations	6%
	Landmine Press, Snatch and Derivatives, Push Press, Sled Sprints, Core Exercise, Glute Ham Raise, Isometric Adductor Exercise	3%
	Other: Bilateral or Unilateral Isolated Exercise Based of Previous Injury History, Upper Body Push, Explosive Dynamic Training, Lower Body Posterior Chain	n/a
5	Bent Over Row	18%
	Core Exercises, Farmers Walk, Pull Ups, Snatch and Derivatives.	9%
	Bench Press, Jerk and Derivatives, Push Press, Turkish Get-Ups	6%
	Clean and Derivatives, Deadlift and Variations, Landmine Press, Leg Press, Lunge and Variations, Nordic Hamstring Curl, Plyometrics, Push Ups, Squat and Variations	3%
	Other: Hamstring ISO Variations, Muscular Isolation Training	n/a

Table 2. Strength and conditioning coaches ranking in order the five most important weightlifting exercises in their program.

*Variations and Derivatives were added when multiple types of the same exercise were reported (e.g., Squat, Overhead Squat, Front Squat).

Type of Stretch	Commonly	Sometimes	Never
Ballistic	6%	55%	39%
Dynamic	85%	15%	0%
Active	61%	36%	3%
Passive	15%	79%	6%
Static	52%	39%	9%
PNF	9%	79%	12%

Table 3. Percentage of responses from strength and conditioning coaches (n = 33) for the frequency in which different methods of flexibility training are used.
*PNF: Proprioceptive Neuromuscular Facilitation.

Rank	Theme	Exemplar Responses	Percentage of Coaches (n = 33)
1	Time / Scheduling / Fixtures	“Contact time within the cricket season. Condensed playing schedules with little time for any strength and conditioning training” and “Playing schedules are becoming increasingly cramped without sufficient time for proper rest, recovery and preparation. Sometimes, we play 3 games in 7 days with travel and practices scheduled”	45%
2	Training Load / Periodization	“Managing the training load is difficult as cricket is played all year around” and “The challenge is finding windows of opportunity to reduce strength/power decay. Speed is easier to maintain as it can be built into warm ups for fielding sessions or on game days”	21%
3	Miscellaneous	“Summers in our league create challenging environmental conditioning in certain locations” and “budgets and politics”	18%
4	Lack of Facilities / Equipment / Staffing	“One coach writing over a 100 player programs each block” and “Due to extensive travel, we don’t always have access to quality facilities and equipment”	15%
5	Athlete Adherence / Buy In	“Adherence to training from athletes as they believe cricket is mainly a skill based sport, and strength and conditioning training takes away from skill practice” and “Athlete compliance/consistency”	15%
6	Colleague Relationship / Opinion Differences	“Head coach stigma and pre conceived ideas from their perspective of strength and conditioning” and “Internal opinions leading to misalignment of goals”	15%
7	Remote Programming / Non-Contact Delivery	“Remotely programming and delivering programs” and “Coaching and managing athletes remotely”	9%

Table 4. Strength and conditioning coach responses to the biggest issues they face as a strength and conditioning coach.

*Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

Rank	Theme	Exemplar Responses	Percentage of Coaches (n = 33)
1	Nothing / Focus on Basics	“Nothing ground breaking, application of the fundamentals on a consistent basis” and “No, we do the basics very well, consistently and to a high standard.”	48%
2	Sport Specific Training	“I deliver a gym-based movement session which mimics cricket actions by driving inter and intra muscular adaptations” and “I try to integrate sessions with the bowling coach, to conduct a joint session combining technical and physical skills for robustness” and “In-season I get as much of our conditioning work through our skill drills, where possible”	21%
3	Miscellaneous	“I let players decide on their program, as I deal with senior players who are mature, so my job is to motivate and guide rather than tell them what to do” and “Integrating internships at various levels of the program”	15%
4	Limited Resources / Facilities	“Our environment is unique due to having poor facilities and we adapt well due to this” and “We have a very small budget so don’t have access to the equipment and information other teams have. However that gives an advantage as we don’t get lost in the data”	12%
5	Types of Exercises Prescribed	We use breathing and relaxation techniques, and also natural movement training” and “I may emphasize isometrics more in season than some other strength and conditioning coaches in cricket”	9%
6	Individualization	“Adapt each exercise to what individuals can perform safely, while still developing strength qualities” and “I first strengthen basic movements, then progress individuals according to their training and injury history”	9%
7	Training Load / Periodization	“We prioritize recovery and restoration above everything else, to keep players as fresh as possible for competition” and “Making sure the weekly structure is planned well, and our bowling workloads are planned to be higher than general acute-chronic workload ratios to increase robustness”	9%

Table 5. Strength and conditioning coach responses to the unique aspects of their strength and conditioning programs.

*Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

Rank	Theme	Exemplar Responses	Percentage of Coaches (n = 33)
1	Position Specific Demands to Individualize Training	"I reverse engineer from the positional demands. For example, fast bowling is unilateral in nature and has high eccentric/isometric lower limb demands. Whereas, batting is unilateral and bilateral in nature and has more concentric lower limb demands" and "Priorities of each position are: Bowlers - full body strength work with limited hypertrophy, strong aerobic base, low body fat and conditioning via actual bowling drills, Batters – agility sessions (run between wickets), speed 5-20m, alactic-aerobic conditioning (via shuttle runs), Fielders – shoulder strength/stability sessions, throwing workload management, combine conditioning (speed, agility and quickness) into fielding drills"	61%
2	Screening / Wellbeing / Testing	"I rely on Physio screening information for each individual to guide me on their needs, together with workload information that I gather on a daily basis" and "Use needs analysis to drive exercise selection - this includes musculoskeletal, performance test data, position & game analysis (e.g., GPS data)"	36%
3	Maturity Status / Long Term Athlete Development	"Also considering training age and physical competency. Rookies have more generic broad programs until movement proficiency gained" and "Based on biological age and training "	9%
4	Goal Setting	"Sessions are individualized based off players and coaches goals" and "Specific work for individuals aligning to their cricket goals"	9%
5	Miscellaneous	"Maybe 1-2 gym exercises but not many, we train all athletes the same way to get them stronger, powerful and fast" and "We group top order batsman and seam bowlers together in order for these athletes to gain the most out of a session"	9%
6	Yes (No Elaboration)	n/a	9%

Table 6. Strength and conditioning coach responses to strategies used to individualize training different positions and athletes.

*Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

Rank	Theme	Exemplar Responses	Percentage of Coaches (n = 33)
1	Technological Equipment / Testing	"Force plates for sensitive strength, rate of force/power testing, GPS for specific load monitoring, heart rate monitoring system for internal load monitoring" and "Better physiological monitoring of training through heart rate and use of force plate/position encoder for power testing"	48%
2	More Time / Training Time with Players	"Spend more time with players on improving limitations" and "Players arrive just before the league starts, which is at the end of the international or domestic season, meaning players can arrive physically and mentally fatigued"	24%
3	Improved Facilities / Equipment / Staffing	"I would love to have a back end support team that would assist in collecting, collating all training, playing and performance data" and "Provide greater nutritional support to the players with a dedicated staff member" and "Better coach to athlete ratio, bigger gym space and centralized facilities for physical training and skills"	24%
4	Miscellaneous	"Employ better feedback mechanisms" and "Players conduct some training remotely"	15%
5	Education	"Recruit a lifestyle manager to educate athletes on nutrition and sleep" and "Focus more on athlete education around training, nutrition, sleep and mental skills"	9%
6	Integration of Science / Research	"I would like to strive to Improve the application of science to produce a program for improving performance" and "More accurately align the scientific accuracy of my programs" and "Further research what impacts performance in cricket"	9%

Table 7. Strength and conditioning coach responses to changes or modifications they would make to their strength and conditioning programs given unlimited time and resources.

*Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

Rank	Theme	Exemplar Responses	Percentage of Coaches (n = 33)
1	Miscellaneous	"More strength and conditioning coaches with PhD's, due to feeling this is becoming increasingly required" and "More ownership from athletes, especially with recent COVID-19 restrictions" and "Remote training"	39%
2	Technology	"Technology use, not only as a monitoring tool but as a training tool, virtual reality is one area I believe will advance moving forward" and "Implanted monitoring devices" and "Technology advancement will improve the ability to give quicker instant feedback, leading to greater improvements" and "Technology devices will continue to flood the market, but it's important to understand what's useful and it should be a small part of programs"	33%
3	Types of Exercises Prescribed	"Potentiation sessions prior to 20/20 matches, more emphasis on power training in batters like baseball to help with boundary hitting and throwing velocity" and "An increase in the use of isometric training" and "Use of more use high intensity interval training drills, and see the 30-15 intermittent test being used as opposed to the yo-yo"	21%
4	Testing and Monitoring	"Workload and wellness monitoring systems and solutions will vastly improve and become a bigger part of cricket high-performance programs" and "The use of digital devices and software to track athlete performance that is accurate"	21%
5	Greater Responsibility for Strength and Conditioning Coaches	"Strength and conditioning coaches will need to be more than just a 'gym coach' and will need to contribute more to pitch based work/ sessions/delivery etc" and "I see strength and conditioning coaches controlling more of the program, becoming the leaders in their performance staff, and eventually strength and conditioning and sport coaching roles combining"	12%
6	Prehabilitation / Injury Reduction	"With evolving load management systems in cricket, strength and conditioning coaches will be able to reduce more players injuries" and "More rehab/injury prevention mechanisms. It is still debatable whether icing and not icing injuries is most effective"	6%
7	Lack of Job Opportunities / Side Business	"Lack of job opportunities" and "More strength and conditioning coaches with side businesses"	6%

Table 8. Strength and conditioning coach responses to what they believe future trends in strength and conditioning will be.

*Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

APPENDIX 1. Survey: Practices of Strength and Conditioning Coaches in Professional Cricket

- Refers to questions with multiple choice answers
- Refers to questions with single choice answers

Other: Was provided for a number of questions in order for participants to provide specific answers, if their practices are different to the pre-determined answers, or if they wished to further elaborate on their answers.

A) Background Information

Q1. Which country are you currently based?

Q2. Gender?

Q3. Age?

Q4. Number of years' experience as a strength and conditioning coach?

Q5. Which league do you currently work in?

Q6. What is your highest level of education?

- Bachelor's Degree
- Master's degree
- PhD
- Other

Q7. Was your degree in a sports science related field? If not, please write your degree below.

- Yes
- No
- Other

Q8. What professional strength and conditioning qualification(s) do you hold?

- Australian Strength and Conditioning Association (ASCA)
- National Strength and Conditioning Association (NSCA)
- Strength and Conditioning Coach Certified (CSCCA)
- United Kingdom Strength and Conditioning Association (UKSCA)
- None
- Other

Q9. What professional cricket coaching qualification(s) do you hold? Write your qualification in other.

- None
- Other

Q10. Have you completed a strength and conditioning internship? Any duration is acceptable.

- Yes (Before certification)
- Yes (During certification)

- Yes (After certification)
- No

B) Muscular Strength and Power Development

Q11. Off-Season: How many strength training sessions do you deliver on average each week?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- Other

Q12. Off-Season: What is your average length per strength training session?

- 0-15 minutes
- 16-30 minutes
- 31-45 minutes
- 46-60 minutes
- 61-75 minutes
- 76-90 minutes
- 90+ minutes
- Other

Q13. Off-Season: What is your typical set range for each exercise in strength training sessions?

- 1-2
- 3-4
- 5-6
- 7-8
- 9-10
- 10+
- Other

Q14. Off-Season: What is your typical repetition range for each exercise in strength training sessions?

- 1-3
- 4-6
- 7-9
- 10-12
- 13-15
- 15+
- Other

Q15. In-Season: How many strength training sessions do you deliver on average each week?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- Other

Q16. In-Season: What is your average length per strength training session?

- 0-15 minutes
- 16-30 minutes
- 31-45 minutes
- 46-60 minutes
- 61-75 minutes
- 76-90 minutes
- 90+ minutes
- Other

Q17. In-Season: What is your typical set range for each exercise in strength training sessions?

- 1-2
- 3-4
- 5-6
- 7-8
- 9-10
- 10+
- Other

Q18. In-Season: What is your typical repetition range for each exercise in strength training sessions?

- 1-3
- 4-6
- 7-9
- 10-12
- 13-15
- 15+
- Other

Q19. How do you determine set loads?

- Repetition maximum
- Predicted repetition maximum
- Trial and error
- Train to failure
- Subjective / Guess
- Athlete dependent
- Ratings of Perceived Exertion (RPE)
- Velocity (e.g., accelerometer)
- Do not determine
- Other

Q20. Do you periodize training?

- Yes
- No
- Other

Q21. How much recovery time do you prescribe between strength and conditioning training, sports training and competition?

	Same Day	24 hr	36 hr	48 hr	> 48 hr
Recovery time between speed development and sports training session					
Recovery time between strength / power development and sports training session					
Recovery time between speed development and competition					

Recovery time between strength / power development and competition					
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Q22. Which Olympic weightlifting exercises or derivatives do you use in your training programs?

- Clean
- Jerk
- Snatch
- Power clean
- Power snatch
- Power jerk
- Hang clean
- Hang snatch
- Clean high pull
- Snatch high pull
- Jump shrugs
- Do not use
- Other

Q23. Which methods of resistance do you commonly use within your training programs?

- Concentric
- Eccentric
- Isometric
- Machine
- Variable (e.g., bands, chains)
- Isoinertial (e.g., flywheel)
- Other

Q24. What is the FIRST most important weightlifting exercise you prescribe in your training program?

Q25. What is the SECOND most important weightlifting exercise you prescribe in your training program?

Q26. What is the THIRD most important weightlifting exercise you prescribe in your training program?

Q27. What is the FOURTH most important weightlifting exercise you prescribe in your training program?

Q28. What is the FIFTH most important weightlifting exercise you prescribe in your training program?

C) Speed Development

Q29. Which methods do you commonly use for speed development?

- Speed running
- Form running
- Resisted running
- Overspeed running
- Maximum speed sprinting
- Plyometrics
- Olympic Weightlifting
- Strength training
- Sport specific movements
- Circuit training
- Interval training
- Uphill/downhill running
- Do not use
- Other

Plyometrics

Q30. What are the main reason(s) you use plyometrics for in your program?

- Total body training
- Lower body power
- Upper body power
- Speed development
- Improve jumping ability
- Injury reduction
- Do not use
- Other

Q31. What stages of the year do you use plyometrics?

- All year round
- Pre-season
- In-season
- Off-season
- Training camp
- Do not use
- Other

Q32. When do you predominantly integrate plyometrics?

- Separate days
- Before weights
- After weights
- Complex training
- Do not use

- Other

Q33. Which plyometric exercises do you commonly integrate into programs?

- Bounding
- Box drills
- Depth jumps
- Jumps in place
- Multiple hops / lunges
- Standing jumps
- Upper body plyometric
- Do not use
- Other

E) Flexibility Development

Q34. When are athletes encouraged or required to perform flexibility exercises in your program?

- After practice
- Before practice
- During practice
- Independently / On their own
- Before workout
- During workout
- After workout
- Do not use
- Other

Q35. What are the most common forms of flexibility training that you use?

	Never	Sometimes	Commonly
Ballistic			
Dynamic			
Active			
Passive			
Static			
Isometric			
PNF			

Q36. What is your average length per flexibility session?

- 0-5 minutes
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21+ minutes
- Do not perform

- Other

F) Physical Testing

Q37. When do you physically test athletes?

- All year round
- Pre-season
- In-season
- Off-season
- Training camp
- Do not test
- Other

Q38. Which of the following physical tests do you use with your athletes? You may write specifically which tests in 'other'.

- Body composition
- Muscular strength
- Cardiovascular endurance
- Anaerobic capacity
- Speed
- Muscular power
- Agility
- Flexibility
- Acceleration
- Muscular endurance
- Anthropometry
- Other

Q39. How do you monitor an athlete's wellbeing?

- Mobile phone or tablet application
- Verbal questionnaire
- Written questionnaire
- Do not monitor
- Other

G) Technology Use

Q40. Which technology-based equipment do you use in your training programs?

- Electronic jump mat
- Bar velocity tracker
- Global positioning system (GPS)
- Mobile phone applications
- Speed gates
- Body composition analyzer

- Heart rate monitor
- Video analysis software
- Force plates
- Metabolic analysis device
- Wearable technology (e.g., smart watch)
- Do not use
- Other

H) Programming

Q41. What is the biggest issues you face as a strength and conditioning coach?

Q42. Do you feel there is anything unique about your program?

Q43. Do you employ any strategies to individualize training for different positions and athletes?

Q44. Given unlimited time and resources, is there anything you would change in your program?

Q45. What do you feel will be a future trend in strength and conditioning?